PHASE ANGLE PREDICTOR OF SARCOPENIA IN PATIENTS WITH STABLE ISCHEMIC HEART DISEASE

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Abstract

Objectives: To examine how phase angle (PhA) contributes to sarcopenia and factors influencing sarcopenia in patients with stable ischemic heart disease (SIHD). ***Methods:*** A cross-sectional descriptive study was conducted on 52 SIHD patients who were recruited, and relevant data was gathered. Patients were diagnosed with sarcopenia based on the Asian Sarcopenia Working Group 2019 (AWGS 2019) diagnostic criteria. Differences between groups were compared, and statistically significant factors were included in the logistic regression analysis to screen for independent factors affecting sarcopenia. The receiver operating characteristics (ROC) and the area under the curve (AUC) were used to evaluate the predictive value of PhA in sarcopenia. ***Results:*** The prevalence of sarcopenia was 36.5% in patients with SIHD. Multivariate logistic regression analysis showed that PhA was an independent factor influencing sarcopenia (OR: 0.078; 95%CI: 0.012 - 0.528; p = 0.009). The AUC of PhA predicting sarcopenia was 0.852, p < 0.001; the best PhA cut-off value for sarcopenia was 5.95° for both sexes (sensitivity and specificity were 0.677 and 0.947, respectively); the PhA cut-off points were 6.05° and 5.25° for men and women, respectively (p < 0.05). ***Conclusion:*** PhA is an important determinant of sarcopenia in patients with SIHD. PhA may have an optimistic predictive value for determining sarcopenia in this population.

Keywords: Stable ischemic heart disease; Sarcopenia; Phase angle.

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INTRODUCTION

Sarcopenia is a disease characterized by progressive deterioration of skeletal muscle mass, accompanied by low muscle strength or muscle dysfunction and often exacerbated by chronic comorbidities, including cardiovascular diseases, chronic kidney disease, and cancer [1]. Sarcopenia is associated with a faster progression of cardiovascular disease and a higher risk of falls, fractures, and other adverse consequences, increasing disability and mortality, particularly among older patients. The prevalence of sarcopenia is about 25% in coronary artery disease (CAD) hospitalized and 12.5% in community-dwelling older adults [2]. Sarcopenia may also be a risk factor for CAD. Previous studies have shown that low skeletal muscle mass among asymptomatic community-dwelling older adults is associated with subclinical atherosclerosis, increased coronary artery calcium score, arterial stiffness, and carotid arterial wall thickening [3, 4]. PhA, a key parameter obtained from bioelectrical impedance analysis (BIA), has attracted significant attention. Recent studies have shown that PhA can predict sarcopenia to a certain degree in healthy elderly people or patients with cachexia due to cirrhosis [5, 6]. Patients with cardiovascular disease are at high risk of sarcopenia. If PhA can be used as a simple indicator for early detection of sarcopenia, it could significantly improve quality of life, reduce treatment costs, and increase survival time in cardiovascular disease patients. Therefore, this study aimed to: *Analyze some factors affecting sarcopenia and investigate the association between PhA and sarcopenia in patients with SIHD.*

MATERIALS AND METHODS

1. Subjects

Including 52 patients meeting the criteria who were included in the analysis.

* *Inclusion criteria:* Patients diagnosed with SIHD (by percutaneous coronary angiography, with or without indication for intervention and coronary artery stenting); aged over 18.

* *Exclusion criteria:* Patients at the time of the study were comatose and had surgery, emergency procedures, and limitations to perform the tests needed to evaluate muscle strength and function, as did those with pacemakers, and those who could not stand were excluded from the study sample.

* *Time and location:* From April 2022 to October 2022 at the Department of Cardiovascular Interventions, Military Hospital 103.

2. Methods

* *Study design:* A cross-sectional descriptive study.

Patients were selected for the study according to the convenience sampling method. Collected data includes patients' general information (age, gender, medical history), anthropometric information (weight, height, calf circumference, BMI), information about the laboratory, information about measuring body composition using BIA (Inbody S10, Seoul, Korea) (skeletal muscle mass index, PhA).

Figure 1. Image of bioelectrical impedance meter (Inbody S10) and measurement results.

* *Measuring skeletal muscle mass index (SMMI) and PhA:* An Inbody S10 bioelectrical impedance analyzer (Seoul, Korea) was used to analyze the body composition of SIHD patients. We performed BIA approximately 24 hours after the patient was admitted to the department. Before measuring BIA, patients were asked to fast for 2 hours, empty their bladder, take things out of pockets, remove necklaces, bracelets, rings, and other jewelry, take off their shoes and socks, wear clothing of known weight, and make contact with their hands and feet with an eight-point tactile electrode. We entered the patient's

name, age, gender, height, and weight in the analysis system and then started measuring BIA. The 8-electrode technique of the Inbody body composition analyzer allows for fractional impedance measurements, performed with a current of 100μA at frequencies from 1 to 1000kHz. The device acquires resistance and reactance values at a frequency of 50kHz and provides additional calculation through a proprietary algorithm developed by the company. SMI is calculated according to height (kg/m^2). PhA was calculated with resistance (R) and reactance (Xc; measured at 50kHz) by the following equation: PhA (°) = arctangent(Xc/R) x (180/π).

* *Measuring muscle strength and physical activity ability (muscle function):* Handgrip strength (HGS) was assessed with an electronic dynamometer (Camry, China) after measuring BIA. The dominant hand is used to hold the dynamometer firmly with the elbow straight away from the body. The measurement is taken twice; the highest value is recorded in kilograms (kg). Muscle function is assessed by sit-to-stand test (SST). Patients sitting in chairs without armrests were asked to stand up and sit down five times at their highest ability. The average value was recorded after two consecutive measurements.

* *Diagnosis of sarcopenia:* According to the diagnostic criteria of the Asian Working Group for Sarcopenia 2019 (AWGS) [7], sarcopenia can be diagnosed when muscle mass loss (SMI < 7.0 kg/m^2 and < 5.7 kg/m^2 in men and women, respectively) plus one of the two criteria of reduced muscle strength (HGS < 28kg and < 18kg in men and women, respectively) and reduced muscle function (time last over 12 seconds).

* *Data analysis:* SPSS version 20 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A logistic regression model was used to screen influencing factors for sarcopenia. The ROC curve and its corresponding AUC were used to evaluate the predictive value of PhA with sarcopenia. The cut-off point was defined as the maximum value of sensitivity + specificity-1. A two-sided $p < 0.05$ was considered a statistically significant difference.

3. Ethics

This study complies with the ethics of biomedical research at Military Hospital 103. Military Hospital 103 granted permission for the use and publication of the research data. The authors declare to have no conflicts of interest in the study.

RESULTS

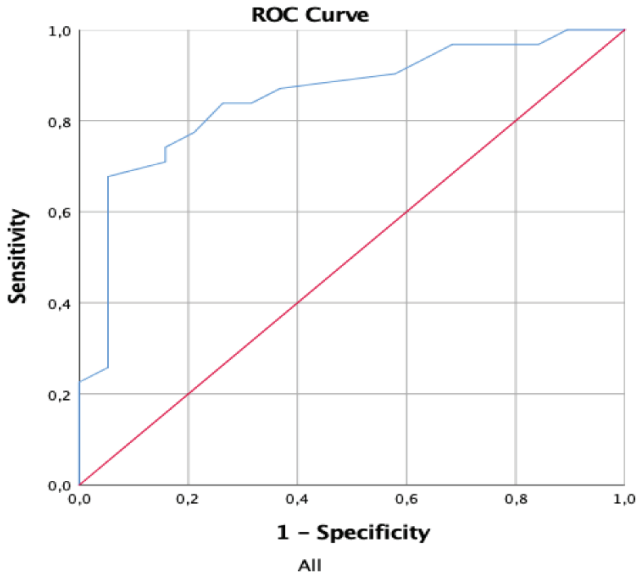
A total of 52 patients were recruited in this study, of which 38 patients (73.10%) were men. The average age was 66.40 ± 10.20 years old; 73.10% of patients were ≥ 60 years old. Among the study subjects, 19 patients (36.5%) were diagnosed with sarcopenia.

Table 1. Multivariate logistic regression analysis of factors influencing sarcopenia (n = 52).

Variables	OR	95%CI	p
Age > 60 (year)	0.81	0.04 - 16.80	0.89
Male	0.96	0.11 - 8.31	0.97
History of hypertension	0.49	0.05 - 4.67	0.54
History of diabetes mellitus	0.60	0.07 - 5.24	0.64
BMI > 25			0.35
BMI: 18.5 - 24.9	8.58	0.15 - 498.90	0.30
BMI < 18.5	7.77	0.48 - 126.30	0.15
Low hemoglobin (g/L)	0.61	0.07 - 5.06	0.64
NLR	1.18	0.93 - 1.49	0.17
High CPR (mg/L)	1.49	0.21 - 10.35	0.68
PhA (°)	0.08	0.01 - 0.53	0.01

(NLR: Neutrophil-to-lymphocyte ratio; BMI: Body mass index; CRP: C-reactive protein)

Table 1 shows a multivariate logistic regression analysis of factors affecting sarcopenia. The results showed that only PhA was an independent factor affecting sarcopenia.



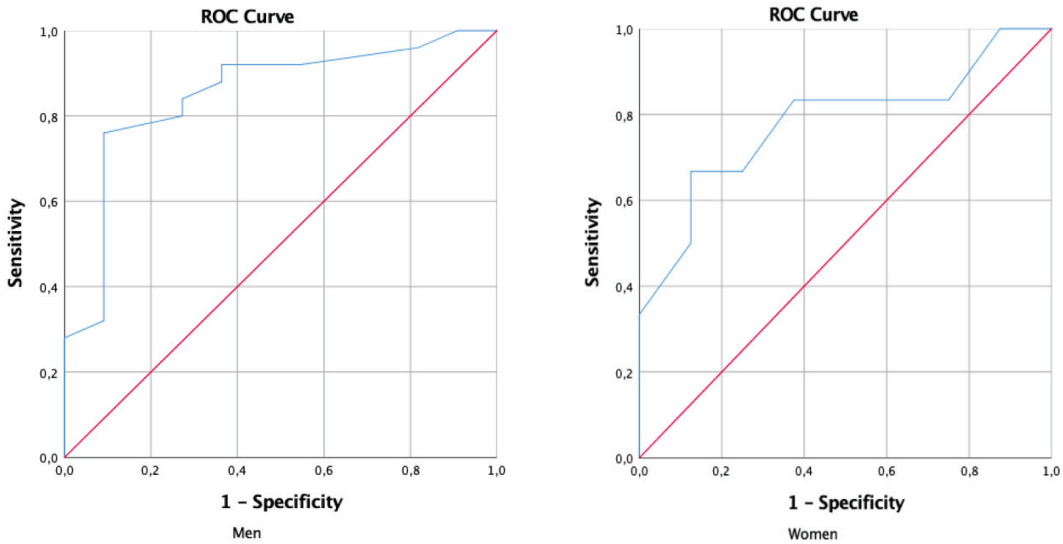
AUC = 0.852; p < 0.001

Figure 2. ROC curve of PhA in the diagnosis of sarcopenia.

Table 2. Cut-off, sensitivity, and specificity of phase angle for diagnosing sarcopenia in the study subjects.

Gender	Cut-off	Sensitivity	Specificity
All (n = 52)	5.95°	0.677	0.947
Men (n = 38)	6.05°	0.760	0.909
Women (n = 14)	5.25°	0.667	0.875

The ROC curve shows the predictability of sarcopenia based on PhA. The AUC was 0.852, and the best cut-off of PhA for sarcopenia was 5.95° for both genders, with a sensitivity of 67.7% and a specificity of 94.7% ($p < 0.001$). The AUC was 0.851, and the best cut-off of PhA for sarcopenia was 6.05° for men, with a sensitivity of 76.0% and a specificity of 90.9% ($p < 0.001$). The AUC was 0.781, and the best cut-off of PhA for sarcopenia was 5.25° for women, with a sensitivity of 66.7% and a specificity of 87.5% ($p < 0.05$). The results determined that PhA has high predictive power in the diagnosis of sarcopenia (*Figure 2, 3*).



AUC = 0.781; p = 0.04 AUC = 0.851; p = 0.001

Figure 3. ROC curve of the ability of PhA to predict sarcopenia in men (left) and women (right).

DISCUSSION

Sarcopenia is a widespread health problem associated with poor physical capacity and poor prognosis in patients with chronic diseases. Current diagnostic criteria for sarcopenia have limitations in their widespread clinical use in large numbers of patients in hospital settings. The present study investigated the role of PhA through BIA (a measure of body composition) as a simple alternative tool for detecting sarcopenia in patients with SIHD and found that it was an independent factor influencing sarcopenia (OR: 0.078; 95%CI: 0.012 - 0.508; p = 0.009). Kilic et al. [8] found that decreased PhA was a risk factor for sarcopenia in elderly patients (OR: 0.59; 95%CI, 0.40 - 0.87; p = 0.008), and the risk of sarcopenia increases 1.69 times for every 1° decrease in PhA. Kosuku, et al. [9] reported that PhA is an important influencing factor of sarcopenia in kidney transplant patients (OR: 0.36; 95%CI: 0.16 - 0.82; p = 0.015). PhA (°) = arctangent (reactance/resistance × 180°/π) using reactance and resistance at 50kHz. Here, the resistance represents the volume of the water reservoir, which is inversely related to the amount of body fluid. Reactance reflects the energy storage capacity of the cell membrane, which is positively related to the number of cells and the integrity of the cell membrane. Literature has reported that PhA is associated with cellular function, inflammation, nutritional status, muscle mass, disease prognosis, and mortality. One possible explanation is that the loss of muscle mass may reduce the amount of water in the cells, so electrical resistance will decrease and PhA will be lower. Second, as a marker of cellular health, PhA is also lower in patients with poor muscle cell function. Third, skeletal muscle mass was also calculated from the resistance and reactance obtained at 50kHz; therefore, part of the association can be explained by this factor.

To further investigate the role of PhA in diagnosing sarcopenia in this chronic disease population, the ROC curve was used to examine the diagnostic role of PhA in sarcopenia. The results showed that the best value for diagnosing sarcopenia in patients with SIHD was 5.95°, which was higher than the results in the study by Hirose et al. [5] on the role of PhA as an indicator of sarcopenia, malnutrition, and cachexia in patients with cardiovascular disease (27% IHD) (4.55° with men and 4.25° with women); Kilic et al. [8] reported an optimal PhA cut-off of 4.55° to detect sarcopenia in 263 community-dwelling and hospitalized older adults (> 65 years). However, our study results were similar to the results

in the study of Reis et al. [10] on kidney transplant subjects, which were 5.80 and 6.20 in men and women, respectively. This may be explained by the differences in population size, mean age, study population, and ethnicity. In addition, it is also possible that the methods of measuring muscle mass and the diagnostic criteria for sarcopenia used in the studies were different, thus influencing the results.

To our knowledge, this is the first study to evaluate the association of PhA with sarcopenia in patients with SIHD. The results of the study suggest that higher PhA is a protective factor for sarcopenia, and therefore, it can be used as a predictor of sarcopenia. When sarcopenia is difficult to diagnose in chronic patients, such as when muscle strength or function cannot be measured or the patient is unwilling to cooperate, we propose to use PhA in clinical practice as an additional assessment method. According to PhA, healthcare professionals can identify patients at risk of sarcopenia in advance and implement appropriate early interventions to prevent the occurrence of sarcopenia and improve the prognosis and quality of life of chronically ill patients. However, this study has some limitations. It is a cross-sectional, single-center study that includes a small number of patients with SIHD, so the generalizability of the results is limited, and it is not possible to conclude a causal relationship between PhA and sarcopenia. In addition, we also excluded patients at the highest risk of sarcopenia, such as bed- or wheelchair-bound patients, critically ill patients, and patients with cognitive impairment.

CONCLUSION

The current study shows that PhA is an independent influencing factor of sarcopenia (according to AWGS 2019) in patients with SIHD. PhA as a nutritional index may have good predictive value to identify sarcopenia in this population.

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